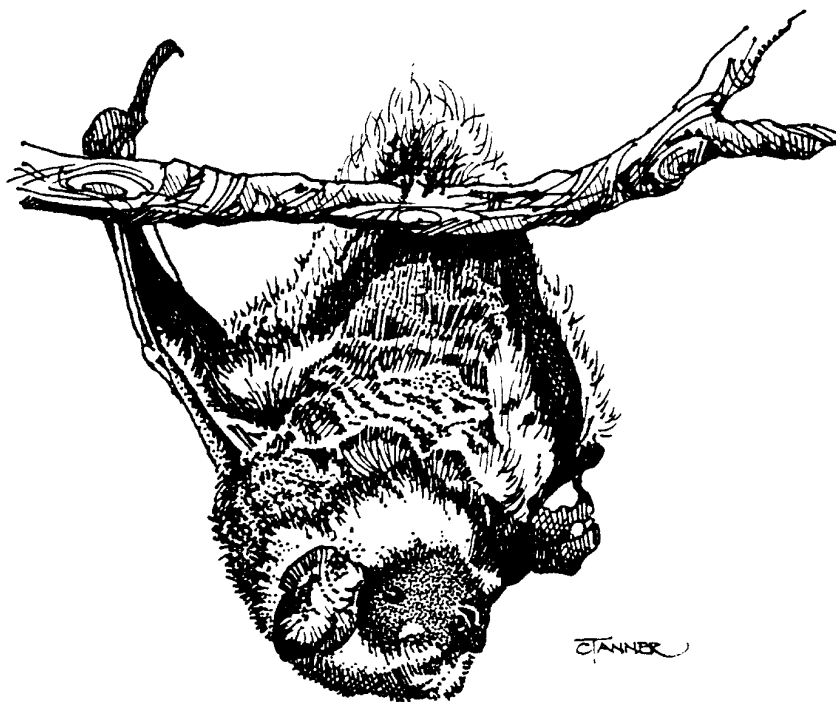


BAT SURVEY OF THE PRESCOTT NATIONAL FOREST (Yavapai County, Arizona)

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BAT SURVEY OF THE PRESCOTT NATIONAL FOREST (YAVAPAI COUNTY, ARIZONA)

Tim K. Snow, Shawn V. Castner, and Debra C. Noel

INTRODUCTION

Mines have been a part of the Arizona landscape for centuries, with important consequences for bats. Coronado's quest for the fabled Seven Cities of Gold and Espejo's ore samples from the Verde Valley around 1583 are some of the earliest mining records for the state (Spude and Paher 1978, Trimble 1989). The first American-led prospecting ventures to interior Arizona occurred in 1863, when the Walker party discovered gold in the Bradshaw Mountains. Also during this time was the discovery of placer gold at Rich Hill (Antelope Mountain) by the Weaver-Peeples party (Trimble 1989, Lauer 1990). These discoveries created a rush of prospectors to this area of the state. Today, prospecting and mining continue throughout these Central Arizona mountain ranges, however, many of the historic mines are now abandoned.

Recently, public safety and other environmental concerns have prompted a great deal of interest toward abandoned mines. Some of these man-made caves are very important bat roost sites. Nineteen of the 28 species of bats found in Arizona use mines to some extent for day, night, transitory, maternity, or hibernaculum roosts. Protection of roost sites is extremely important in ensuring the existence of these species.

The U.S. Fish and Wildlife Service (USFWS) recently elevated the status of eight additional Arizona bat species, bringing the total to one endangered and 13 Category 2 bat species (those for which data indicates listing as threatened or endangered may be appropriate). The Arizona Game and Fish Department's (AGFD) 1988 list of *Threatened and Native Wildlife in Arizona (TNW)* recognizes one endangered and five threatened bat species. These two lists support the need to locate and protect bat roosts.

For these reasons, the AGFD Bat Management Project (BMP) has begun comprehensive surveys to locate bat roosts throughout Arizona. The abundance of abandoned mines and lack of bat occurrence records prompted a survey of the Prescott National Forest (PNF) funded through a cost share agreement. The objective was to locate new roosts and enhance bat occurrence records for all three PNF ranger districts. In 1993, the BMP conducted abandoned mine surveys which included mines on the PNF. Data from both surveys are included in this report.

SURVEY AREA

The PNF was created by consolidation of the Prescott and Verde Forest Reserves in 1908 (Granger 1973). It encompasses nearly 1.5 million acres, and three ranger districts: Chino

Valley (CVRD), Verde (VRD), and Bradshaw (BRD). About half of PNF is south and west of Chino Valley in the Juniper, Santa Maria, Sierra Prieta, and Bradshaw mountains. The rest is east of Chino Valley from Black Mesa, Mingus Mountain, and the Black Hills south to Pine Mountain (Fig. 1). Elevations on the PNF range from less than 3000 to almost 8000 feet. Because of this elevational diversity, temperature and precipitation vary throughout the PNF. The vegetation also varies from Upper Sonoran Desert to Montane Conifer (Brown 1994).

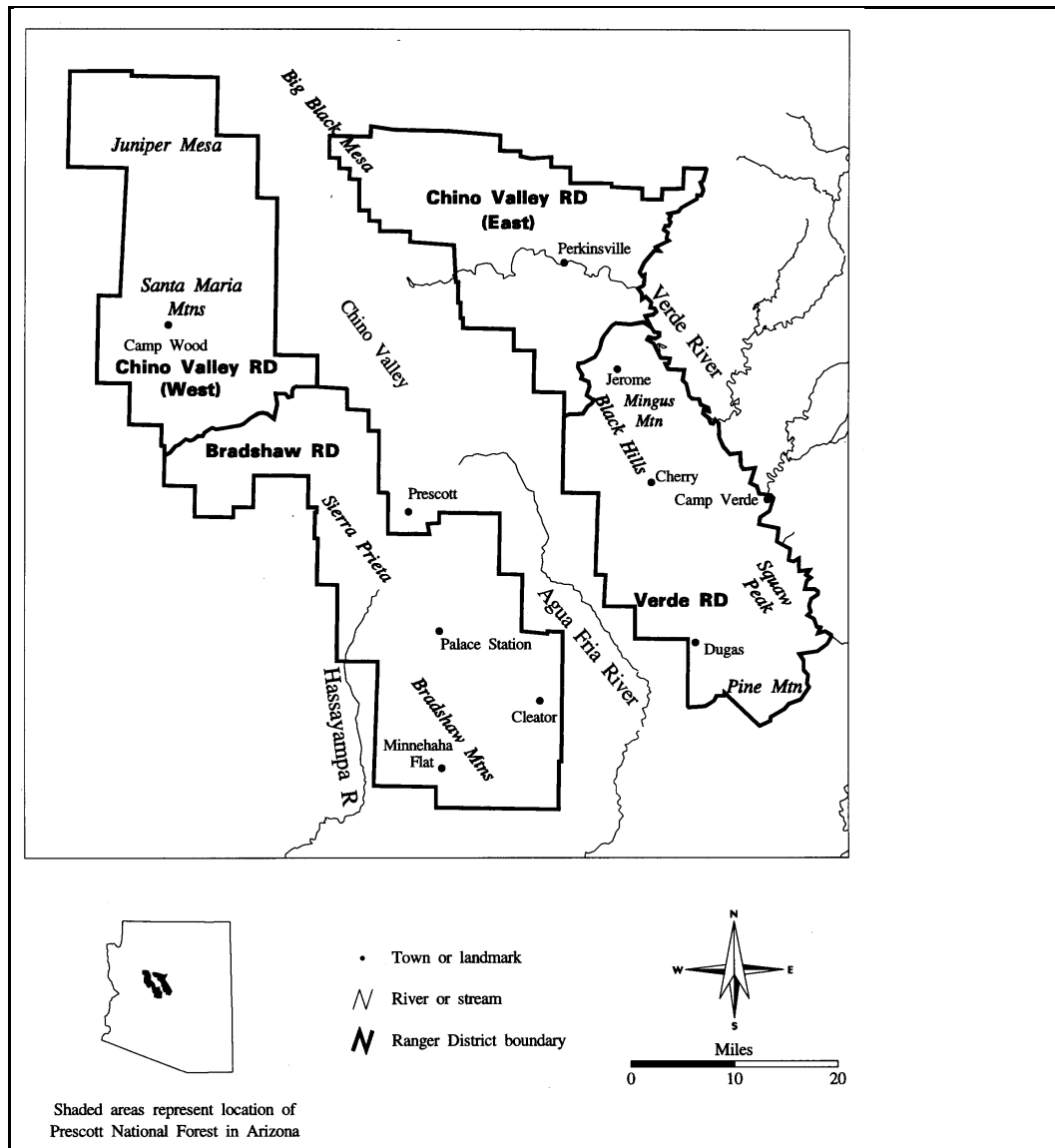


Figure 1. Map of the Prescott National Forest, Yavapai County, Arizona.

SPECIES OCCURRENCE

A literature search of all historical roost sites and collection records was performed by contacting the Museum of Vertebrate Zoology, Berkeley, California; Los Angeles County Museum of Natural History; U.S. Museum of Natural History, Smithsonian Institution; and the AGFD Heritage Data Management System. In addition, we reviewed the records in *Mammals of Arizona* (Hoffmeister 1986). We found very little information collected within the PNF. Most collections were obtained from areas adjacent to the PNF, such as: Camp Verde, Dry Beaver Creek, Ft. Whipple, Yarnell, and Skull Valley. The earliest record for the area is the fossilized teeth of a *Lasiurus blossevillei* collected from the Verde Formation (Czaplewski 1993). Based on this information, we compiled the following occurrence table of those bat species likely to occur on the PNF.

Table 1. Bat species likely to occur on the Prescott National Forest, Yavapai County, Arizona.				
Common Name Scientific Name	Status		Habitat	Primary Roost Structure
	ESA ¹	TNW ²		
California leaf-nosed bat <i>Macrotus californicus</i>	C2	SC	Sonoran Desertscrub below 4000 ft	caves/mines
Yuma myotis <i>Myotis yumanensis</i>	C2	-	Desert to Pinyon-Juniper forages over open water	caves/mines buildings
Cave myotis <i>Myotis velifer</i>	C2	-	Desert; may hibernate in mines above 6000 ft	caves/mines bridges
Occult little brown bat <i>Myotis lucifugus occultus</i>	C2	-	Pinyon-Juniper to Pine	caves/mines tree cavities
Long-eared myotis <i>Myotis evotis</i>	C2	-	Pinyon-Juniper to Mixed Conifer	caves/mines tree cavities
Southwestern myotis <i>Myotis auriculus</i>	-	-	Desertscrub to Pine	caves/mines tree cavities
Fringed myotis <i>Myotis thysanodes</i>	C2	-	Chaparral to Pine	caves/mines
Long-legged myotis <i>Myotis volans</i>	C2	-	Ponderosa to Mixed Conifer	caves/mines buildings
California myotis <i>Myotis californicus</i>	-	-	Desert to Pine	caves/mines crevices
Small-footed myotis <i>Myotis ciliolabrum</i>	C2	-	Grassland to Pine	caves/mines crevices

¹Endangered Species Act; C2 = Category 2

²Threatened Native Wildlife in Arizona, 1988; SC = State Candidate

Table 1 (cont.). Bat species likely to occur on the Prescott National Forest, Yavapai County, Arizona.				
Common Name Scientific Name	Status		Habitat	Primary Roost Structure
	ESA ¹	TNW ²		
Silver-haired bat <i>Lasionycteris noctivagans</i>	-	-	Ponderosa Pine to Mixed Conifer	tree bark buildings
Western pipistrelle <i>Pipistrellus hesperus</i>	-	-	Desert to Pine	caves/mines crevices
Big brown bat <i>Eptesicus fuscus</i>	-	-	Desertscrub to Mixed Conifer	caves/mines buildings
Western red bat <i>Lasiurus blossevillii</i>	-	SC	Broad-leaved Woodlands Riparian	tree foliage
Hoary bat <i>Lasiurus cinereus</i>	-	-	Desertscrub to Mixed Conifer	tree foliage
Spotted bat <i>Euderma maculatum</i>	C2	SC	Desertscrub to Pine near cliffs	cliff crevices
Allen's lappet-browed bat <i>Idionycteris phyllotis</i>	C2	-	Ponderosa Pine	caves/mines tree cavities
Townsend's big-eared bat <i>Plecotus townsendii</i>	C2	-	Desert to Pine	caves/mines buildings
Pallid bat <i>Antrozous pallidus</i>	-	-	Desert to Pine	caves/mines buildings
Mexican free-tailed bat <i>Tadarida brasiliensis</i>	-	-	Desert to Pine	caves/mines buildings
Pocketed free-tailed bat <i>Nyctinomops femorosaccus</i>	-	-	Desert to Chaparral	cliffs buildings
Big free-tailed bat <i>Nyctinomops macrotis</i>	C2	-	Desertscrub to Pine	cliffs
Western mastiff bat <i>Eumops perotis</i>	C2	-	Desert to Pine	cliffs

¹Endangered Species Act; C2 = Category 2

²Threatened Native Wildlife in Arizona, 1988; SC = State Candidate

METHODS

Mist Netting

We used mist nets to enhance species occurrence, abundance, and habitat use records on the PNF. Mist nets were set in riparian or drainage areas and across ponds that had potential as flyways or watering locations. Sites were selected at random with an emphasis on sampling all habitat types on the PNF. Mist nets were composed of 30-50 denier, 2 ply, black nylon with a 3.8 centimeter mesh. Net height and length were adjusted depending on the site. Visual sightings and electronic bat detectors were used to verify bat presence. Data collected at each net set included: date, observer(s), site location, legal description, habitat description, weather conditions, number of nets set, starting and ending time, time of capture, species, sex, age, reproductive condition, weight, and lengths of the forearm.

Potential Roost Sites

A "priority" list of potential roost sites was provided by each PNF District Biologist emphasizing areas with current managerial needs. Additional mines located close to those on the priority list were also surveyed. Mines located on Bradshaw Mining, LLC property (Button Mine Claims) were surveyed at the request of the mining company and the PNF.

The mines investigated during our survey included adits, shafts, and prospects. Some areas included several of these types. The mine site classification system used was based on field experience and the various symbols used on USGS topographical maps and is as follows:

Adits - horizontal tunnels that vary in length from three to several hundred meters. These can be straight or with many twists and turns. It is possible to have additional drifts (horizontal passageways) within adits. The USGS topographical symbol is "Y."

Shafts - vertical passages with depths greater than three meters. These may be straight or declining with varying slopes and may or may not contain drifts. Some of the vertical shafts could not be surveyed due to safety precautions. The USGS topographical symbol is a half-shaded box.

Prospects - small, shallow holes or scrapes constructed to prove claims or explore new areas. These do not exceed 3 meters in depth when shaft-like or length when adit-like. The USGS topographical symbol is "X."

Our site examination consisted of exploring the potential roost site for evidence of bat use, such as prey remains, guano deposits, skeletal remains, and bat presence. We recorded: date, observer(s), site location and name, type (cave, adit, shaft, prospect, cliff dwelling, building), aspect of entrance, temperature, relative humidity, species, sex, and number of bats present. Hand nets were used to capture bats when species identification could not be made from visual observations. We also mapped the internal configuration noting specific bat roosting locations, sightings of other wildlife, and signs of human disturbance. A sling psychrometer was used to measure relative humidity.

In addition, we assessed each site according to the following guano accumulation index: (1) no guano, (2) scattered or small piles (less than 30 centimeters in diameter or 3.8 centimeters deep), (3) large piles (greater than 30 centimeters in diameter or 3.8 centimeters deep) or complete coverage of the floor.

RESULTS

We sampled 10 habitat types during our mist netting surveys. Our 89 net hours of effort yielded 63 individuals representing 13 species. Although some of our netting efforts resulted in zero captures, bats were observed with electronic bat detectors at all sites. In addition, we conducted 200 roost site surveys and found bats or evidence of bat use at 72 of these sites.

District results are as follows:

Chino Valley Ranger District

Mist Netting. Mist netting was performed at five sites during September and November 1994 (Table 2). We captured 49 individuals of 10 species. The species included *Myotis yumanensis*, *M. lucifugus occultus*, *M. evotis*, *M. auriculus*, *M. californicus*, *Pipistrellus hesperus*, *Eptesicus fuscus*, *Lasiurus cinereus*, *Antrozous pallidus*, and *Tadarida brasiliensis*.

Potential Roost Sites. Eight sites were surveyed for potential bat roosts on the CVRD (Table 3). These included six mines, one cliff dwelling, and one cave. Three sites contained small populations of *Myotis thysanodes*, and two others had guano but no bats.

Verde Ranger District

Mist Netting. Five sites were netted during October 1994 (Table 4). Nine individuals of four species were captured. The species included *Myotis yumanensis*, *M. velifer*, *M. auriculus*, and *Lasiurus blossevillii*.

Potential Roost Sites. Seventy-six sites were surveyed for potential bat roosts (Table 5). These included 74 mines, one cave, and one building. Eighteen sites contained small bat populations and seven others had guano but no bats. No guano was found in four of the 18 sites with bats. The species observed included *Myotis yumanensis*, *M. velifer*, *M. lucifugus occultus*, *M. evotis*, *M. auriculus*, *M. thysanodes*, *M. californicus*, *Plecotus townsendii*, and *Antrozous pallidus*.

Bradshaw Ranger District

Mist Netting. Five sites were netted during November 1994 (Table 6). Five individuals of four species were captured. The species included *Myotis californicus*, *Lasiurus cinereus*, *Plecotus townsendii*, and *Tadarida brasiliensis*.

Potential Roost Sites. We surveyed 116 sites for potential bat roosts (Table 7). These included 115 mines and one railroad tunnel. Eighteen sites contained small bat populations and 24 others had sign but no bats. No guano was found in five of the 18 sites with bats. The species observed included *Myotis velifer*, *M. californicus*, *Eptesicus fuscus*, and *Plecotus townsendii*.

Button Mine Claims. We surveyed 20 mines at the request of the Bradshaw Mining, LLC and the PNF (Table 7, Minnehaha Quad). Four mines contained bats, including *Myotis californicus*, *Eptesicus fuscus*, and *Plecotus townsendii*. Two other mines showed evidence of bat use. Three of these mines were on the Bradshaw Mining, LLC's property, while 17 were on Forest Service land.

The six sites that had bats present or showed signs of bat use were revisited in February 1995. Two of the sites still contained torpid bats. None of these sites showed an increase in use from the previous visit.

Table 2. 1994 bat mist netting results - Chino Valley Ranger District, Prescott National Forest							
Location/ UTM	Habitat ¹ / Elev. (ft)	Date	Temp (°F)		Nets Set	Net Time (hrs)	Number of Bats
			Start	End			
Emerald Glade E329740, N3853580	PP 5590	9/6/94	79	56	3	3.5	1
Cottonwood Canyon E327650, N3844780	CH Riparian 4830	9/7/94	81	54	3	4	2
Hickey Tank (Lower) E392920, N3841840	PP 7140	9/8/94	64	57	2	2	0
MC Tank E384900, N3871160	PJ 4510	9/19/94	85	68	2	3.5	0
Verde River E385220, N3863260	PJ Riparian 3890	11/28/94	40	21	1	3	0

¹PP = Ponderosa Pine; CH = Chaparral; PJ = Pinyon Juniper

²Individuals that escaped prior to sex determination.

Table 3. 1994 bat roost survey sites - Chin			
Quad name	Sites Surveyed	Guano l	
		1	2
Hell Point	3	1	2
King Canyon	1	0	1
Munds Draw	2	2	0
Picacho Butte SE	2	0	2
Total	8	3	5

¹Guano rating: 1) none. 2) scattered or small piles. 3) large piles or covering the floor.

Table 4. 1994 bat mist netting results - Verde Ranger Dis			
Location/ UTM	Habitat ¹ / Elev. (ft)	Date	Te
			Star
Gap Creek E427430, N3808190	PJ Riparian 2950	10/3/94	72
Hank's Tank E402660, N3821360	CH 4570	10/4/94	68
Little Ash Creek E405440, N3804880	MG Riparian 3730	10/5/94	62
Sycamore Creek E410500, N3801830	PJ Riparian 3950	10/18/94	68
Goddard's Tank #1 E408230, N3835410	MDS 3590	10/19/94	58

¹PJ = Pinyon-Juniper; CH = Chaparral; MG = Mesquite-Grassland;
 MDS = Mesquite-Desert Scrub

²Individuals that escaped prior to sex determination.

Table 5. 1993-94 bat roost survey sites - Verde Ranger District, Prescott						
Quad name	Sites Surveyed	Guano Rating ¹			Sites With Bats	
		1	2	3		
Arnold Mesa	2	1	1	0	1	<i>A</i>
Cherry	41	34	7	0	6	<i>Mye</i>
Cottonwood	6	2	4	0	2	<i>A</i>
Hickey Mountain	6	5	1	0	1	
Horner Mtn.	7	4	3	0	0	
Humboldt	8	5	3	0	4	<i>A</i>
Mayer	4	2	2	0	3	<i>A</i>
Middle Verde	2	2	0	0	1	
Total	76	55	21	0	18	<i>Mye</i>

¹Guano rating: 1) none. 2) scattered or small piles. 3) large piles or covering the floor.

Table 6. 1994 bat mist netting results - Bradshaw Ranger			
Location/ UTM	Habitat ¹ / Elev. (ft)	Date	Ter
			Start
Crook's Canyon E369700, N3801130	PO Riparian 5460	11/21/94	48
Ash Creek E370810, N3785960	CH Riparian 5240	11/22/94	48
Hassayampa River E359800, N3808880	CH Riparian 4680	11/23/94	53
Black Canyon Creek E389500, N3786390	USD Riparian 2720	11/29/94	54
Upper Mesa Tank E389380, N3799420	PJ-Grassland 4140	11/30/94	50

¹PO = Pine-Oak; CH = Chaparral; USD = Upper Sonoran Desert;
 PJ = Pinyon Juniper

²Individuals that escaped prior to sex determination.

Table 7. 1994 bat roost survey sites - Bradshaw Ranger Distr					
Quad name	Sites Surveyed	Guano Rating ¹			Sites With Bats
		1	2	3	
Battleship Butte	13	10	3	0	1
Cleator	22	13	8	1	4
Crown King	2	2	0	0	0
Groom Creek	32	23	9	0	5
Minnehaha	20	14	5	1	4
Poland Junction	2	0	2	0	0
Wilhoit	25	17	8	0	4
Total	116	79	35	2	18

¹Guano rating: 1) none. 2) scattered or small piles. 3) large piles or covering the floor.

DISCUSSION

Mist Netting

The CVRD had the highest capture rate, 1.34 bats per net hour, and accounted for 78 percent of all bats netted. The BRD had the lowest, 0.23 bats per net hour, and 8 percent of the captures. However, this does not mean that the CVRD has more bats or better habitat than the other districts.

The variations in capture rate were not the result of differences in netting effort. Our netting time was based on each site's bat activity. Our data showed a very slight correlation (Pearson corr. = 0.63, $P = 0.012$) between capture rate and netting time. Therefore, other factors must have contributed to the difference in capture rates.

Many factors can create adverse effects on capture results including wind, precipitation, moonlight, cold temperatures, and the duration of each. For example, when we divided the average netting temperatures (ANT) for each site (derived from the starting and ending temperatures) about the mean ANT (55.4°F) for all sites, there was a significant difference ($t = 2.59$, d.f. = 13, $P < 0.05$) between the capture rates of bats netted during low versus high temperatures (Figure 2). Thus, temperature effected our capture rate.

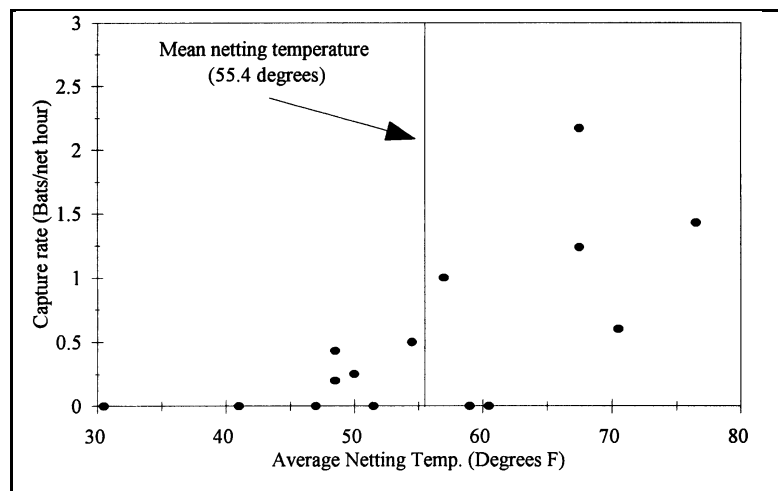


Figure 2. Capture rate vs. average netting temperature.

The time of year can also affect capture results, as most Arizona bats hibernate or migrate during the winter. There was a strong correlation (Pearson corr. = 0.84, $P = 0.0001$) between time of year and ANT during this project. In other words, the ANT decreased from September to November. Thus, the capture rates associated with lower temperatures may be a result of the decline in bat activity during hibernation and migration.

Mine Roosts

When discussing the percentage of mines that are used by bats, it is important to omit the number of mines surveyed that do not have potential as bat habitat. Not all of the mines listed by the three Districts had potential as bat habitat (Table 8). Some of the mines that we visited did not have underground workings. Others had completely collapsed portals. Prospect shafts or pits less than 5 meters deep were also omitted as potential habitat. Prospect adits were considered as usable habitat. Therefore, we

surveyed 125 mines on the PNF that had potential bat habitat and found evidence of bat use in 68 (54.4%).

Table 8. Mines surveyed with potential bat habitat - PNF, Yavapai County, Arizona.				
District	Mines Surveyed			
	Total	Without Bat Habitat	Potential Bat Habitat	
			With Evidence of Bat Use	No Evidence of Bat Use
Chino Valley	6	0	3	3
Verde	74	32	24	18
Bradshaw	115	38	41	36
Total	195	70	68	57

Researchers continue to study microclimate requirements for bats. However, no distinct limiting factor has been determined between those mines used and unused by bats. One explanation for the high percentage of mine use on the PNF may be the proximity of these sites to surface water, which provides for hydration and forage. Although we did not record distance to water data during our survey, it was apparent that the PNF has an abundance of surface water. Also, many of the mines have underground water flows which increases humidity within each site.

RECOMMENDATIONS

1. Additional mist netting surveys for bats should be conducted on all PNF districts. Dividing this project among the three ranger districts resulted in a low number of net nights for each. Additional surveys will greatly enhance occurrence records and may even lead to areas with unknown maternity roosts. These efforts should be conducted during May-July when bat activity is at its peak.
2. A maternity season survey should be conducted on the 72 sites that showed signs of bat use. Water accumulation, which accelerates guano deterioration, was evident in many of the mines

surveyed. Therefore, roost classifications could not be made for these sites. Conducting maternity season surveys will aid in roost classification and identify the species using each site.

3. Disturbances should also be monitored at the 72 roosts found. Human disturbance can be extremely detrimental to bat colonies, especially to non-volent young and hibernating adults. Most of the survey sites listed by the three ranger districts were accessible by four-wheel drive vehicles. Signs of disturbance such as foot prints, litter, etc. were found in most of the sites. It is very difficult to determine the time frame of the disturbances and the effect they had on current or former bat colonies.

Button Mine Claims

1. An alternative closure, such as gating, should be enacted on the Rush #1 adit. The six sites that showed evidence of bat use, including the four with bats, were revisited during February so that we could obtain a better understanding of their winter uses. Although we only found a small population of bats during our efforts, the Rush #1 adit appears to be an important hibernaculum for *Plecotus townsendii*. This adit accounted for 72 percent and 90 percent of the bats observed on the Button Mine Claims during each respective visit. The spring inside this adit may be an important water source for other animals as well; two mule deer (*Odocoileus hemionus*) were observed leaving this site during our first visit.
2. The road to the Rush #1 adit should be closed. In February 1995, there was evidence of additional disturbance at the Rush #1 adit. It looked as if someone had used the mine as a backdrop for target practice. Beer cans with bullet holes were found at the portal to the mine, indicating the shots were fired into the adit. Although gating will not deter using mines as target backgrounds, we believe that removing or blocking the road to this mine will prevent most of the disturbances.
3. The six sites mentioned above should be revisited during the maternity season (May-July). One of these mines contained a small guano pile indicating a possible maternity roost. Resurveying these sites will identify the species and the number of individuals using each site during this important time.
4. It is unnecessary to prolong closure of the 14 sites that showed no signs of bat use. However, we do stress the importance of a walk-through inspection of each site immediately prior to any closure action. Although not in this area, we did find nine sites that contained bats but did not have any guano. Therefore, it is possible for any site to contain transient bats and removal of these individuals prior to permanent closure is essential.

CONCLUSIONS

This report is a compilation of the data collected during 1994 mist netting and potential roost site surveys on the PNF. We confirmed the occurrence of 14 species and located 72 new roost sites. Exact locations of roosts have been omitted from this report in accordance with guidelines recommended by the American Society of Mammalogists' Conservation of Land Mammals Committee (Sheffield et al. 1992). Land management agencies requiring more specific site descriptions should contact the AGFD Heritage Data Management System.

In addition to the data collected during this project, this report includes 1993 mine survey data collected within PNF boundaries. This additional data supplements the 1994 PNF surveys and provides valuable information regarding mine uses by bats. Results from both surveys indicate that mines are very important to bats which occur on the PNF on a year-around and seasonal basis.

Hopefully, in the future, surveys such as this will begin to answer some of the many remaining questions regarding the life history, habitat requirements and seasonal movements of bats. Only with personal efforts and cooperative funding, such as took place during this project, will these answers come to light.

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